# ILLICIT TRAFFICKING OF RADIOACTIVE MATERIALS AND REGULATORY ISSUES IN TURKEY

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## ABSTRACT

The recycle and reuse of materials have been increasing during recent years, particularly because of recognition of the economic opportunities presented, but also because of an increased societal awareness of the desirability of conserving raw materials and natural resources. Lost, stolen and abandoned sources appearing in recycled metals constitute a world wide problem. Radioactive sources sometimes incorporate into scrap metal for subsequent recycling. Most of these incidents have resulted in significant levels of radioactive contamination with the attendant risks to employees and the general public. During the past decade there have been numerous accidents where these shielded sources have been accidentally mixed with scrap metal, and have been subsequently melted or ruptured particularly in steel making process. For controlling of incoming trucks and trains in case the presence of radioactive sources hidden in the scrap, there is a need to establish a radiation detecting system.

In Turkey in addition to pocket sized or handheld radiation monitors, fixed or mobile panel detection systems will also be used in the detection of illicit trafficking of radiation sources and contaminated scrap material. But besides this activity; training courses have been carried out to improve the knowledge and skills of workers and the customs officers dealing with radiation sources and scrap materials.

## INTRODUCTION

Radioactive materials are used throughout the world for a wide variety of beneficial purposes in industry, medicine, research, defense and education. There have been instances in which loss of security over radioactive materials has led to serious, even fatal consequences to public. Since radioactive sources encased in metal shields their containers can have certain attractiveness because of their value as a scrap metal.

The subsequent handling of such sources and containers by workers, recycling metal dealers or members of the public unaware of the inherent hazard can give rise to external irradiation or the possibility of exposure. These incidents sometimes may lead to serious injury and in some cases even to death.

Turkish Atomic Energy Authority (TAEA) is the regulatory body for giving legal permission to import, transport, exchange or export of radiation sources in Turkey. One of the companies based in Ankara, which was licensed by TAEA, transferred two sources to a warehouse on an industrial estate in Istanbul. After approximately 9 months, the new owner of the warehouse sold the two sources of the containers as scrap. Although the containers ware labeled the person

who purchased them was unaware of the radiation sign and started to attempt to dismantle on December 1998. A total of 10 people who were close to the dismantled containers felt ill. For about 2 weeks, pieces of the dismantled containers and one unshielded source were left in a residential area before being transferred to a local scrap yard. The source was remained unshielded for further 2 weeks. When the injuries were eventually suspected as being the case of radiation, TAEA were immediately notified. As a result unshielded source was quickly discovered at the scrap and safely recovered. The activity of the source was estimated as 3 TBq. A total of 404 people applied for medical checks and 18 people were admitted to hospitals. Acute radiation exposure symptoms were determined in 10 adults [1].

## RADIOACTIVE SOURCES IN RECYCLING MATERIALS

The recycle and reuse of materials have been increasing during recent years, particularly because of recognition of the economic opportunities presented, but also because of an increased societal awareness of the desirability of conserving raw materials and natural resources. Lost, stolen and abandoned sources appearing in recycled metals constitute a world wide problem. Radioactive sources sometimes incorporate into scrap metal for subsequent recycling. Most of these incidents have resulted in significant levels of radioactive contamination with the attendant risks to employees and the general public. These incidents may also result with serious economic consequences. Clean up costs resulting from such accidents have been ranged US $8-10million dollars, and in one event the cost was US$23 million [2]. During the past decade there have been numerous accidents where these shielded sources have been accidentally mixed with scrap metal, and have subsequently been melted or ruptured during steel making process. 60 occasions in which radioactive sources have been accidentally melted since 1983 is given in Table 1. As it is seen from the Table, main metals used in recycling industry are gold, steel, aluminum, lead, copper, zinc and lead [3].

**Table 1.** Melting of Radioactive Materials [3]

| | Year | Scrap metal | Location | Isotope | Activity (Gbq) |
|---|---|---|---|---|---|
| 1 | | Gold | NY | 210Pb,210Bi | Unknown |
| 2 | 1983 | Steel | Auburn Steel, NY | $^{60}$Co | 930 |
| 3 | 1983 | iron,steel | Mexico | $^{60}$Co | 5000 |
| 4 | 1983 | Gold | Unkown | $^{241}$Am | unknown |
| 5 | 1983 | Steel | Taiwan | $^{60}$Co | >740 |
| 6 | 1984 | Steel | US pie & Foundary, AL | $^{137}$Cs | 0.37—1.9 |
| 7 | 1985 | Steel | Brazil | $^{60}$Co | unknown |
| 8 | 1985 | Steel | Tamco CA | $^{137}$Cs | 56 |
| 9 | 1987 | Steel | Florida Steel FL | $^{137}$Cs | 0.93 |
| 10 | 1987 | aluminum | United Technologies, IN | $^{226}$Ra | 0.74 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 1988 | Lead | ALCO pacific, CA | $^{137}Cs$ | 0.74—0.93 |
| 12 | 1988 | copper | Warrington, MO | accelera. | unknown |
| 13 | 1988 | Steel | Italy | $^{60}Co$ | unknown |
| 14 | 1989 | Steel | Bayou Steel, LA | $^{137}Cs$ | 19 |
| 15 | 1989 | Steel | Cytemp, PA | Th | unknown |
| 16 | 1989 | Steel | Italy | $^{137}Cs$ | 1000 |
| 17 | 1989 | aluminum | Russian Federation | unknown | unknown |
| 18 | 1999 | Steel | NUCOR Steel, UT | $^{137}Cs$ | unknown |
| 19 | 1990 | aluminum | Italy | $^{137}Cs$ | unknown |
| 20 | 1990 | Steel | Ireland | $^{137}Cs$ | 3.7 |
| 21 | 1991 | Steel | India | $^{60}Co$ | 7.4-20 |
| 22 | 1991 | aluminum | Alcan Recycling, TN | Th | unknown |
| 23 | 1991 | aluminum | Italy | $^{137}Cs$ | unknown |
| 24 | 1991 | copper | Italy | $^{241}Am$ | unknown |
| 25 | 1992 | Steel | Newport Steel, KY | $^{137}Cs$ | 12 |
| 26 | 1992 | aluminum | Reynolds, VA | $^{226}Ra$ | unknown |
| 27 | 1992 | Steel | Border Steel, TX | $^{137}Cs$ | 4.6—7.4 |
| 28 | 1992 | Steel | Keystone Wire, IL | $^{137}Cs$ | unknown |
| 29 | 1992 | Steel | Poland | $^{137}Cs$ | unknown |
| 30 | 1992 | copper | Estonia | $^{60}Co$ | unknown |
| 31 | 1993 | unknown | Russian Federation | $^{226}Ra$ | unknown |
| 32 | 1993 | Steel | Russian Federation | $^{137}Cs$ | unknown |
| 33 | 1993 | Steel | Auburn Steel, NY | $^{137}Cs$ | 37 |
| 34 | 1993 | Steel | Newport Steel, KY | $^{137}Cs$ | 7.4 |
| 35 | 1993 | Steel | Chaparral Steel, TX | $^{137}Cs$ | unknown |
| 36 | 1993 | Zinc | Southern Zinc, GA | U (dep.) | unknown |
| 37 | 1993 | Steel | Kazakhstan | $^{60}Co$ | 0.3 |
| 38 | 1993 | Steel | Florida Steel, FL | $^{137}Cs$ | unknown |
| 39 | 1993 | Steel | South Africa | $^{137}Cs$ | <600 Bq/g |
| 40 | 1993 | Steel | Italy | $^{137}Cs$ | unknown |
| 41 | 1994 | Steel | Austeel Lemont, IN | $^{137}Cs$ | 0.074 |
| 42 | 1994 | Steel | US Pipe & Foundry, CA | $^{137}Cs$ | unknown |
| 43 | 1994 | Steel | Bulgaria | $^{60}C$ | 3.7 |
| 44 | 1995 | Steel | Czech Rep | $^{60}Co$ | unknown |
| 45 | 1995. | Steel | Czech Rep | $^{60}Co$ | unknown |
| 46 | 1995 | Steel | Italy | $^{137}Cs$ | Unknown |
| 47 | 1996 | Steel | Sweden | $^{60}Co$ | 87 |
| 48 | 1996 | Steel | Austria | $^{60}Co$ | Unknown |

| | | | | | |
|---|---|---|---|---|---|
| 49 | 1996 | Lead | Brazil | $^{210}Pb$, $^{210}Bi$, | Unknown |
| 50 | 1996 | aluminum | Bluegrass Recycling, KY | $^{232}Th$ | Unknown |
| 51 | 1996 | aluminum | White Salvage Co., TN | $^{241}Am$ | Unknown |
| 52 | 1996 | Steel | WCI, OH | $^{60}Co$ | 0.9 (?) |
| 53 | 1997 | Steel | Kentucky Electric, KY | $^{137}Cs$ | 1.3 |
| 54 | 1997 | Steel | Italy | $^{137}Cs/^{60}Co$ | 200/37 |
| 55 | 1997 | Steel | Greece | $^{137}Cs$ | 11 Bq/g |
| 56 | 1997 | Steel | Birmingham Steel, AL | $^{137}Cs/^{241}Am$ | 7 Bq/g |
| 57 | 1997 | Steel | Brazil | $^{60}Co$ | <0.2 |
| 58 | 1997 | Steel | Bethlehem Steel, IN | $^{60}Co$ | 0.2 |
| 59 | 1998 | Steel | Spain | $^{137}Cs$ | >37 |
| 60 | 1998 | Steel | Sweden | $^{192}Ir$ | <90 |

**Scrap Trading Activities in the World and in Turkey**

Illicit trafficking of radioactive materials may be defined as the unauthorized receipt, possession, use, or transfer of radioactive materials, whether intentional or unintentional and with or without crossing international borders [4]. In illicit trafficking of radioactive materials, attention must be paid to the characteristics of scrap trading activities. Metal scrap may be radioactively contaminated material or sometimes-shielded radioactive sources even of high activity may be deeply buried in scrap, which sometimes may not be detected without highly sensitive monitoring systems. illicit trafficking in radioactive materials especially in metal scrap has taken on greater significance in recent years and is concern of many countries in the world. It should be noted that recycling scrap is actually a major way of producing fresh metal. It is estimated that the global movements of these raw materials involve 400 million tons per year.

Turkey is one of the leading recycling steel importing countries in the World. Steel and other kind of metal scrap import rate is increasing every year. In 1993, steel-scrap was imported as 4 million tons with an economic value of approximately 575 million-US dollars. This was increased to 11.9 million tons in 1999, which corresponds to 2.5 billion US dollars, as given in Table 2 [4].

**Table 2.** Recycling Steel Imported to Turkey [4]

| Year | Thousand tons |
|---|---|
| 1993 | 4.503 |
| 1994 | 4.082 |
| 1995 | 5.078 |
| 1998 | 10.322 |
| 1999 | 11.861 |

Main Turkish recycling steel companies are given in Table 3. Generally these companies use their own ports during import or export. Main ports of imported recycling steel and their percentages according the data obtained in 1999 are given as Aliağa (%38), Gebze (%26), Ambarlı (%14), Isdemir (%14), Samsun (%7). Hopa Port which is in Black Sea region is the main port (%47 of total import in 1999), for recycling aluminum. The others are Halkalı (%19), Gürbulak (%11), Haydarpasa (%7) and Izmit (%9) [4].

**Table 3** Main Recycling Steel Import Companies in Turkey [4]

| Recycling Steel Importing Companies | Thousand tons |
|---|---|
| Içdas Demir Çelik | 1.625 |
| Habas | 1.527 |
| Çolakoglu | 1.314 |
| Izmir Demir Çelik | 1.069 |
| Ekinciler | 911 |
| Diler | 867 |
| Yazici | 852 |
| Koraman | 761 |
| Yesilyurt | 759 |
| Çebitas | 754 |
| Çukurova | 685 |
| Total (including small companies) | 11.900 |

**Detection of Sources**

For controlling incoming trucks and trains on the presence of radioactive sources hidden in the scrap there is a need to a radiation detecting system. Monitoring should be at control points where there is the greatest potential for identifying illicit trafficking; for example, at the site boundaries of the factories using metal scrap or national scrap traders facilities and at the customs check points. Fixed installation or mobile panel monitors are used to detect medium and high gamma emitters, including Co-60, Cs-137, Ir-192, Ra/Th also unshielded Am-241 and neutrons [5-6]. They should be installed as close as possible to the objects to be monitored in order to obtain the greatest practical sensitivity. Their sensitivity to detect radiation field start

from 0.1 μSv/h to 10 μSv/h with respect to their price. The system sensitivity depends on a number of factors such as: detector size, distance between detectors, uniformity in height of the scrap in the truck, background radiation level, source type and position within the load, truck speed, truck size, load density, load composition, acceptable false alarm rate. These systems are characterized by a high sensitivity and reliability, are easy to operate and virtually maintenance free [7-8].

The Council Directive 96/29/EURATOM of the European Communities and International Atomic Energy Agency (IAEA), Basic Safety Standarts (BSS) states the exemption level of 10 Bq/g of $^{60}$Co activity. For surface contamination the recommended clearance level for reused of materials are in the range of 0.1 Bq/cm$^2$ and 10 Bq/cm$^2$. TAEA recommends the investigation level as 0.2-0.3 μSv/h from 1m distance, which are two or three times higher than the background radiation level. The investigation level of 0.3 μSv/h from 1m distance is equivalent to a surface contamination in the order of 20 Bq/cm$^2$. The German regulation provides detailed information on the radiological consequences and reasoning for the choice of the action level of 5μSv/h.[11].

**RESULTS AND CONCLUSION**

After the radiological incident occurred in Spain in 1998 [2] as a consequence of melting a radioactive source of $^{137}$Cs recycling steel inspection and control will be achieved at about 90 different points and detection systems will be voluntarily installed. The Spanish Ministry of Industry also considers the possibility of issuing an Act establishing compulsory fulfillment of this step.

In Turkey, detection of both nuclear and other radioactive materials at border crossing as well as inside country is planned in combating illicit trafficking of radiation sources. In addition to pocket sized or handheld radiation monitors, fixed or mobile panel detection systems will also be used in the detection of illicit trafficking of radiation sources or contaminated metal scrap. Turkey is the similar country to Spain with 12 million tons of imported metal scrap. At the moment, installing 90 checkpoints may not be feasible with respect to Turkey's economic situation but plans are continued to establish reasonable number of fixed or mobile panel-type detection systems. Besides that, some training courses have been given free of charge to improve the knowledge and skills of workers and the customs officers dealing with radiation sources and scrap metal. These courses are in regular base and the contents are:

a) the nature and effects of ionizing radiation,

b) the properties and applications of radioactive materials,

c) considerations and techniques for monitoring and detection,

d) National legislation for radiation protection, safety and security,

e) the appropriate response activities in the event of detection of radioactive materials.

Additional studies are being carried out to define the procedures that must be followed in the event that some radioactive material is detected or radiological incident occurs. These

procedures are particularly considered very significant in order to provide an effective control in the incident situations.

Private or public companies that monitor scrap metals should provide the emergency response plans to TAEA and these plans should cover the followings items,

a) notification procedure,

b) details of information to be supplied in emergency situation,

c) the measures to be supplied to aid recovery of control,

d) the temporary storage arrangements for any radioactive material that might be found,

e) the arrangements for transportation to final authorized storage or disposal facility,

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